MARGINAL NOTES

INTRODUCTION

Howser Creek and its tributary, Tea Creek, are located in southeastern BC (Fig. 1) approximately 70 km north of Kaslo and 15 km east of Duncan Lake in the west-central Purcell Mountains. Access to the area can be gained from the eastern shore of the lake via the Howser Creek Forest Service road.

Follow-up sampling of the Howser and Tea creeks area was completed as part of a 1999 field program to check areas with a potential for Fe oxide-Cu-Au-REE mineralization of the Candelaria-Kiruna-Ernest Henry-Olympic Dam family (Hitzman and Oreskes, 1990; Hitzman et al., 1992; Oreskes and Hitzman, 1993; Ryan et al., 1995; Marschik and Fontboté, 1996; Williams, 1999; Ray and Webster, 2000). This program initially involved a library search together with an examination of the BC MINFILE and Regional Geochemical Survey (RGS) data bases. MINFILE contains details on more than 12 000 mineral occurrences and the province-wide RGS data has involved the collection of over 45 000 stream sediment samples.

Our data-search suggests that some areas in BC have mineral or geochemical indications suggesting they contain mineralization of the Candelaria-Kiruna-Ernest Henry Olympic Dam type. Favourable indicators includes the occurrence of abundant low-titanium Fe-oxides (magnetite, ilmenite), elevated Fe, Co, U, Au ± P ± REE-litho or stream sediment chemistry, diagnostic K and/or Na metasomatism, together with the presence of geological features such as deep-seated faults and Fe-oxide-rich breccias.

The Howser-Tea creeks drainage area was selected for this investigation mainly because the RGS database had recorded a number of samples in the district that were anomalous in Au, Fe and La. These sediment anomalies were not only in Tea and Howser creeks, but in the upper reaches of Horsethief Creek further east and in Cornwall and Vowell creeks to the north (Matysek et al, 1978). The district north and northeast of the Howser-Tea creeks area also contain several placers enriched with various Fe, U, P, Nb and REE-bearing minerals such as magnetite, ilmenite, apatite, allanite and monazite; these placers are present at Vowell, East, and Malloy creeks (MINFILE numbers 082KNE006, 007, 008 and 023). In addition, the presence of Proterozoic metasediments deposited in a rifted continental cratonic setting was thought to be highly favourable because some major Fe oxide-Cu-Au-REE deposits elsewhere in the world (e.g. Ernest Henry and Olympic Dam) occur in a similar geological environment.

The authors spent two days in the field area. Thirteen stream sediment samples were collected (Fig. 2), including silt from the two anomalous sample-sites revealed in the RGS program. In addition, six rock samples with sulphide or quartz alteration were collected for assay, and the geology of both the bedrock and stream-boulders in the area were examined.

GEOLOGY AND MINERALIZATION IN THE HOWSER-TEA CREEKS AREA

The district was recently mapped by Warren (1996) and the geology of the Howser and Tea creeks area shown in Figure 3 is based on that work. The area is largely underlain by Windermere Supergroup metasediments of the Neoproterozoic Horsethief Creek Group. At higher elevation there are remnants of the Late Neoproterozoic to Early Cambrian age Hamill Group. Approximately 4 km east of the Howser and Tea creeks confluence the Horsethief Creek rocks are intruded by a small granodiorite intrusion of presumed Late Jurassic-Early Cretaceous age (Fig. 3; Warren, 1996).

The sedimentary rocks represent a variety of coarse to fine grained clastics that include quartzitic and arkosic sandstones, grits, argillites and impure limestones and dolomites; some grits include coarse grains of white, glassy and blue quartz. The rocks were deposited on the western margin of ancestral North America during several early phases of continental rifting. Subsequently, they underwent regional low-grade metamorphism and intense polyphase, ductile and brittle deformation that produced north-northwest trending tight to isoclinal folds and some thrust faults (Fig. 3). Most rocks have been metamorphosed to greenschist facies but lower grade rocks also occur and the metasediments represent slates, phyllites and sericitic schists. No identifiable bedding/younging directions were observed, but sericite mineral lineations measured in schists along Tea creek suggest that the folds in that area plunge 20 to 30 degrees in a southeasterly direction.

No mineral occurrences are recorded in the Howser-Tea creeks area by the B.C. MINFILE, although galena-bearing float was discovered during this survey (Fig. 2). Some slates and phyllites in the area are rusty weathering and locally contain disseminated pyrite; sericite schists and phyllites are common, particularly in many of the sampled streams. Seven outcrops with a dense network of veining were seen (Plates 1 and 2); the best occurs in the upper parts of Tea Creek (Fig. 2), approximately 200 m south of sample site SS099-4 at UTM Zone 11, NAD 27, 517630E, 5595299N.

The quartz veins are synteectonic, multiphase (Plate 3) and are preferentially developed in the more competent sedimentary rocks. They are probably related to brittle-ductile movement along the thrusts, particularly the Tea Creek Thrust (Fig. 3). They are mostly < 1cm thick (Plates 1-3) but veins up to 1.5 m wide were observed in boulder float. In some outcrops the veins are sheeted, forming parallel, closely-spaced sets that follow the schistosity. Veins that cross-cut the schistosity are commonly deformed by open to tight ductile folds (Plate 1). Most of the veins comprise white quartz with minor (2-5%) coarse sericite and calcite; in a few veins the quartz is rose coloured. Many have small, limonite-stained vugs lined with euhedral quartz crystals. Some also contain 1 to 2 percent pyrite, either as isolated cubic crystals or in thin stringers. However, at the confluence of Tea Creek and one west-flowing tributary (sample site SS099-4, UTM 517640E, 5595495N, the boulder float contains white quartz veins hosting 2 to 5 cm-thick zones of pyritic alteration. A nearby outcrop of black phyllitic argillite also contains abundant disseminated crystals of pyrite. During this sampling program quartz vein float containing minor galena was noted in one tributary of Tea Creek (Fig. 2; sample site SS099-1; UTM 516158E; 5599583N); the galena was verified by XRD analysis and is coated by unidentified Pb-oxides (M. Chromly, personal communication, 1999). As well as containing abundant float of quartz-veined metasedimentary rocks, cobbles of a strongly chloritized biotite-hornblende granodiorite were noted in this tributary; there are presumably derived from the small granodiorite plug located 2.5 km further east (Fig. 2; Warren, 1996).

ROCK ASSAY RESULTS

Assay results on 6 samples of quartz-veined metasediments collected from bedrock and stream float are shown in Table 1. One sample (GR99-71) contained minor galena, and another (GR99-72) included material from the pyritic halves in the wallrock adjacent to the veins.

Only one sample contained detectable Au (sample GR99-74 with 20 ppb Au), and the galena-bearing sample (GR99-71) has enhanced values of Pb and Bi. All six samples are relatively enriched in Cr (up to 349 ppm) which is unusual for rocks with this mineralogy and from this geological setting. The weakly anomalous Cr values possibly reflect the presence of minor Cr-rich mica with the sericite.

SEDIMENT SAMPLE RESULTS

The results for the 13 stream silt samples from Tea and Howser creeks are shown in Table 2. For comparison, the computed 90th and 95th percentiles for the province-wide RGS data-base are shown in Table 3B. The Howser-Tea creeks drainage was selected for this follow-up study largely because 2 RGS samples collected previously from Tea Creek had Au, Fe and La values exceeding the 90th percentile (Table 3A & B; Matysek et al., 1987).

Three of the 13 samples (SS099-1, 4 and 5) contain > 13 ppb Au which exceeds the 90th percentile for Au as compared to the complete RGS data-base (n=1 g, 1 ppm int). Sediment than 90th percentile values for Au, Fe, Pb, Bi, La and Ce are also seen in some samples. Bismuth values are low (< 0.4 ppm). A few samples contain high Fe values (> 6 % Fe), but there is a poor correlation between the Fe values recorded in the 2 RGS samples collected from the Tea Creek drainage (Fig. 2; samples 82KT75260 and 82KT75270; Tables 2 & 3A), and those in sediment collected from the same locations during this study (samples SS099-6 and 4; Fig. 2). Neutron activation methods gave Fe values of 6.7 % and 7.9 % for the 2 RGS samples which falls above the 90th percentile for Fe in the RGS data-set. By contrast, similar analytical methods on the follow-up samples from these locations contained 5.2 % and 6 % Fe which is less than the 90th percentile.

SUMMARY & CONCLUSIONS

- The Howser-Tea creeks drainage area lies within a Hibb thrust belt and is underlain by a package of Windermere Supergroup slates, sericite schists and phyllites that were deposited in a continental margin sedimentary environment. The metasediments are intruded by a small plug of biotite-hornblende granodiorite. Thrusting was accompanied by the formation of extensive quartz vein stockworks. Some veins carry pyrite but most are barren although one piece of galena-bearing quartz float was found in the Tea Creek drainage.
- Previous reconnaissance sampling during an RGS survey indicated that sediments in the Howser-Tea creeks drainage are anomalously high in Fe, Au and some REE's. More detailed sediment sampling during this study numerically confirmed the earlier conclusions concerning Au and REE's, although the Fe values are somewhat lower. A comparison with the 90th percentile values computed for the province-wide RGS program indicates that some Tea Creek silt samples are anomalous in Au, As, Pb, Cr, BE, La and Ce.
- Maximum values of 26 ppb Au, 110 ppm As, 142 ppm La, 211 ppm Ce and 6.8 % Fe were recorded in the silts.
- The cause of the Au, As and REE anomalies in the Tea Creek sediments is uncertain, as is the source of the magnetite-ilmenite-apatite-allanite-monazite-bearing placers that occur elsewhere in the district (e.g. at Vowell, East, and Malloy creeks).
- Assay results (Table 1) suggest that the Tea Creek sediment anomalies are not related to the thrust-related quartz vein stockworks and there is no geological evidence, as yet, that either carbonates or Candelaria-Kiruna-Ernest Henry-type Fe oxide-Cu-Au-REE mineralization occur in the district.
- The anomalies may be related to the granodiorite plug that outcrops east of Tea Creek, which raises possibilities that Pegs-type mineralization or other forms of intrusion-related Au may be present in the district. However, were extensive with anomalous Au and REE values drain areas that have no recognized intrusive rocks (e.g. samples SS099-4 and 5; Fig. 4).
- Due to difficult access, the Windermere Supergroup metasediments in this region have probably been under-prospected for precious metals. Ongoing construction of new logging roads and trails in the area will hopefully encourage more exploration in the district for magmatic-related Au ± REE hydrothermal systems.

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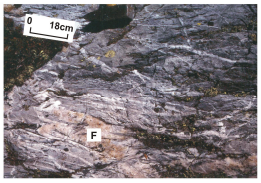

Plate 1. Horsethief Creek Group cut by quartz-vein stockwork. Note sheeted veins parallel to schistosity and folded cross-cutting veins (F). Teacup Creek, UTM 517630E; 5595199N.

Plate 2. Horsethief Creek Group cut by sheeted quartz-veinss. Teacup Creek, UTM 517630E; 5595199N.

Plate 3. Boulder float of grits with blue quartz grains and two generations of quartz-sericite veins, Teacup Creek.

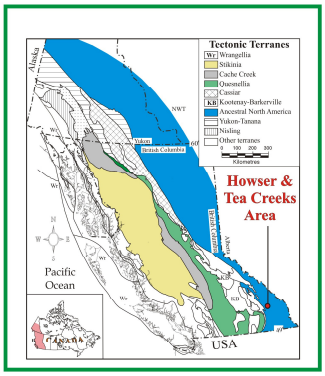

Figure. 1. Tectonic Terrane Map of the Canadian Cordillera showing location of the Howser & Tea Creeks Area, Purcell Mountains, Southeast BC. Terrane map after Wheeler et al., 1991.

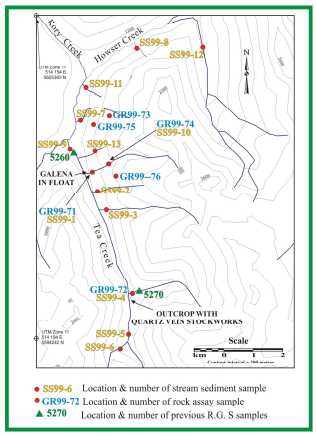

Figure 2. Location of sediment and rock assay samples, Howser & Tea Creeks area, southeast BC.

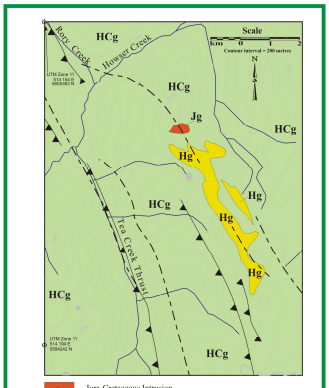

Figure 3. Geology of the Howser & Tea Creeks area (after Warren, 1996).

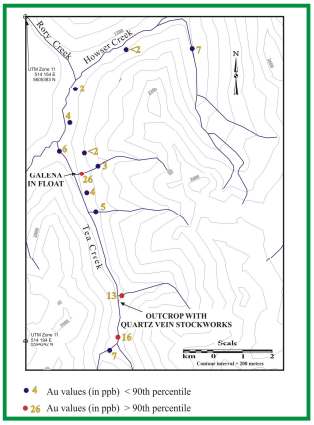

Figure 4. Au values (ppb) in stream sediments. Sample points in red and black = Au values greater and less than the 90th percentile in the BC Regional Geochemical Survey.

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FOLLOW-UP INVESTIGATION OF REGIONAL STREAM SEDIMENT Fe-Au-REE ANOMALIES, HOWSER & TEA CREEKS, PURCELL MOUNTAINS, SOUTHEAST BC (82K/10)

By G.E. Ray & I.C.L. Webster

Field work carried out 27th & 28th of August 1999

Table 1: Assay data of rock samples from the Howser & Tea Creeks area, Purcell Mountains

SAMPLE	GR-99-71	GR-99-72	GR-99-73	GR-99-74	GR-99-75	GR-99-76
Au	<5	<5	<5	20	<5	<5
Ag	1.1	<0.05	<0.05	0.25	0.05	<0.05
As	2	3	3	3	1	<1
Ba	<10	20	10	30	120	<10
Be	<0.05	0.2	0.05	0.15	0.5	<0.05
Bi	6.64	0.09	0.13	0.04	0.35	0.02
Cd	0.06	0.14	0.02	0.66	0.04	0.14
Ce	1.41	11.6	1.52	8.28	13.5	0.83
Co	0.65	0.65	0.15	0.45	1.4	0.05
Cr	298	258	341	279	349	317
Co	5	1	2	4.2	3.8	1.6
Cu	48	5	23	515	14	8
F	30	80	30	40	180	30
Ga	0.3	1.3	0.4	1.4	5.1	0.3
Ge	1.6	1.2	1.2	1.5	1.7	1.8
Hg	<10	<10	<10	<10	<10	<10
La	0.5	5.5	0.5	4	7	<0.5
Li	0.6	2.6	0.2	2	15.4	0.2
Mn	235	90	110	865	495	1005
Mo	1.2	1.2	1.4	1.4	1.8	1.2
Ni	16	7.6	10.4	13.8	16.2	6.2
Nb	<0.2	0.2	<0.2	<0.2	0.4	<0.2
P	50	120	90	30	370	40
Pb	457	15	11	4	18.5	1.5
Rb	1	7	2.2	7.6	27.8	0.8
Sb	0.4	0.1	<0.1	0.1	0.4	0.1
Sr	9.2	64.5	2.4	36.4	25.4	41.4
Ta	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Te	0.7	<0.05	<0.05	<0.05	<0.05	<0.05
Tl	<0.02	0.02	<0.02	0.02	0.18	<0.02
Th	<0.2	1.2	0.2	0.6	3.4	<0.2
U	<0.2	<0.2	<0.2	0.2	0.8	<0.2
V	3	3	3	6	16	1
W	0.3	0.5	0.4	0.1	0.4	0.2
Y	0.8	1.3	0.5	2	3.8	3.5
Zn	6	12	4	34	18	10
Al	0.11	0.72	0.16	0.51	1.87	0.05
Ca	0.2	0.55	0.02	0.88	0.11	0.85
Fe	0.95	0.48	0.46	1.28	1.54	1.1
K	0.02	0.17	0.05	0.15	0.6	0.01
Mg	0.06	0.05	0.01	0.16	0.21	0.19
Na	0.05	0.23	0.04	0.1	0.11	0.02
Ti	<0.01	0.01	<0.01	<0.01	0.02	<0.01

Au and Hg in ppb
Al, Ca, Fe, K, Mg, Na & Ti in percent
All other elements in ppm
Analyses completed at Chemex Labs Ltd., 212 Brooksbank Ave, North Vancouver, B.C.
Methods: Au = Fire assay and AA finish; F = Specific Ion Electrode; As = AAS; other elements = ICP-MS

Sample descriptions for Table 1.:
GR99-71: White quartz vein w ith sericite, vuggy hematite-goethite and galena. Collected from 15 cm w ide piece of float in stream.
GR99-72: Quartz-pyrite-vein from a large (1.5m) boulder of altered metasediments cut by a stockw ork of limonite-stained w hite quartz veins w ith pyritic halves.
R99-73: Quartz vein from an outcrop of chloritic, altered metasediments. Veins are up to 0.2 m w ide and have limonite-stained vugs.
R99-74: Quartz-pyrite-rich sample from a 15cm w ide float in stream bed. The veins are w hite to rose-coloured and cut by pyrite stringers.
GR99-75: Quart vein sample from large boulder.
GR99-76: Float of quartz vein with limonite vugs.

Table 2: Analyses of Stream Sediment Samples, Howser & Tea Creeks, Purcell Mountains, BC.

Method			SS99-1	SS99-2	SS99-3	SS99-4	SS99-5	SS99-6	SS99-7	SS99-8	SS99-9	SS99-10	SS99-11	SS99-12	SS99-13
			Sample Nos.												
Au	NA	ppb	26.0	4.0	5	13	16.0	7	4	<2	6	3	2	7	<2
Ag	AAS	ppm	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	0.2	0.2	<0.2	0.2	<0.2	0.2	0.3
As	AAS	ppm	14.0	10.0	19.0	11.0	110	25.0	7.2	0.4	65.0	17.0	7.0	10.0	11.0
Bi	AAS	ppm	0.2	0.2	0.2	0.3	0.4	0.4	0.2	0.3	0.2	0.3	0.2	0.2	0.2
Cd	AAS	ppm	0.2	<0.2	0.2	0.2	<0.2	0.2	0.3	0.2	<0.2	0.2	0.2	0.3	0.3
Cu	AAS	ppm	36	34	46	45	69	64	25	39	47	40	31	41	38
F	AAS	ppm	350	230	440	460	270	500	360	450	360	440	300	310	350
Hg	AAS	ppb	20	20	10	10	10	20	20	10	<10	10	10	20	30
Mn	AAS	ppm	412	430	585	598	633	456	371	395	504	530	342	285	506
Ni	AAS	ppm	35	42	51	44	60	56	29	37	44	39	29	34	47
Pb	AAS	ppm	14	16	22	33	17	16	13	22	17	15	12	12	21
Sb	AAS	ppm	0.4	0.5	0.4	0.8	0.7	0.4	0.4	0.4	0.5	0.5	0.2	0.4	0.3
V	AAS	ppm	12	11	13	5	12	7	13	16	8	9	10	12	13
Zn	AAS	ppm	49	50	58	73	77	86	49	47	69	63	47	43	63
Ba	NA	ppm	370.0	220.0	430	440	490.0	420	480	530.0	370	420	420	430	390.0
Br	NA	ppm	6.9	2.4	6	<0.5	<0.5	4	6.1	4.0	<0.5	7.6	2.5	1	8.6
Co	NA	ppm	16.0	17.0	21	20	26.0	27	15	22.0	20	18	17	20	21.0
Cr	NA	ppm	79.0	78.0	104	73	91.0	96	86	98.0	82	88	85	84	84.0
Cs	NA	ppm	4.0	3.0	4	3	4.0	4	3	4.0	4	4	3	2	4.0
Hf	NA	ppm	11.0	10.0	9	14	11.0	9	14	15.0	11	12	17	16	9.0
Hg	NA	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ir	NA	ppb	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Mo	NA	ppm	3.0	<1	<1	<1	<1	<1	<1	4.0	<1	<1	<1	<1	<1
Ni	NA	ppm	97.0	<21	113	<22	86.0	137	<24	111.0	<22	<22	<22	<21	<20
Rb	NA	ppm	92.0	76.0	94	84	101.0	107	77	92.0	65	88	66	63	79.0
Sb	NA	ppm	0.6	0.7	1	2	1.2	0	0.5	0.4	0.9	0.6	0.5	0.5	0.7
Sc	NA	ppm	11.2	10.6	14	10	12.8	13	11.4	12.7	11.2	12.6	10.6	10.6	12.5
Se	NA	ppm	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Ta	NA	ppm	1.0	0.8	<0.5	<0.5	2.2	2	<0.5	1.0	<0.5	<0.5	0.8	1.6	1.5
Th	NA	ppm	19.0	16.7	17	18.9	25.9	20	19.5	21.0	21.1	19.4	19.1	23.5	16.4
U	NA	ppm	4.8	3.6	5	4	5.3	5	4.5	4.2	4.2	5.2	5.2	4.8	4.6
W	NA	ppm	<1	<1	<1	4	3.0	<1	<1	<1	<1	<1	<1	<1	<1
Zn	NA	ppm	102.0	86.0	103	130	133.0	121	114	104.0	95	70	75	62	89.0
La	NA	ppm	91.7	69.9	71	85.8	147.0	89	86	80.7	99.1	98.5	89.9	107	64.1
Ce	NA	ppm	144.0	112.0	110	132	211.0	136	141	133.0	150	155	148	164	101.0
Nd	NA	ppm	51.0	40.0	43	46	78.0	49	51	50.0	60	63	56	61	41.0
Sm	NA	ppm	12.2	9.3	9	11.1	17.4	12	11.9	11.6	12.6	13.7	13	14	8.7
Eu	NA	ppm	2.3	1.8	2	2.1	3.0	2	2.3	2.3	2.3	2.5	2.6	2.7	1.8
Tb	NA	ppm	1.2	1.1	1	1.3	1.5	1	1.2	<0.5	1.1	1.3	1.5	1.4	1.0
Yb	NA	ppm	3.7	3.7	3	4.1	4.7	4	4.2	4.4	4.1	3.9	5.2	4.7	3.5
Lu	NA	ppm	0.6	0.6	1	0.63	0.7	1	0.65	0.7	0.63	0.59	0.77	0.68	0.5
Fe	NA	%	4.3	4.4	5	6	6.8	6	4.06	4.7	5.21	4.53	4.24	4.46	4.5
Fe	AAS	%	2.1	2.2	3.1	3.6	5.3	3.1	2.0	2.3	3.4	2.3	2.0	2.2	3.1
Na	NA	%	0.9	0.9	1	1	0.7	1	0.91	1.0	0.79	0.83	0.77	0.9	0.8
LOI	AAS	%	2.7	3.2	4.5	3.0	3.2	2.6	3.8	3.7	4.5	3.9	2.4	1.8	6.7

Aqua regia analysis completed at Chemex Labs Ltd., 212 Brooksbank Ave, North Vancouver, B.C.
Neutron Activation (NA) completed at Activation Laboratories Ltd., 1336 Sandhill Drive, Ancaster, Ont.

Table 3A: Analytical results of two RGS samples from Tea Creek (see Fig. 2 for locations).

Master ID	Au	Pb	As	As	Bi	Cr	Fe	Fe	Co	Cr	Hf	La	U
82KT75260	51	16	66.1	-	-	78	3.40	6.70	250	-	24	205	6.1
82KT75270	32	12	83.9	-	-	78	2.15	7.90	210	-	19	150	72.3

Table 3B: 90th & 95th percentile summary data of province-wide RGS sampling program (approx. 45 000 sediment samples).**

	Au	Pb	As	As	Bi	Cr	Fe	Fe	Co	Cr	Hf	La	U
Method	INAA	AAS	AAS	INAA	AAS	AAS	AAS	INAA	INAA	INAA	INAA	INAA	INAA
Percentile													
90th	13	16	27	23	0.4	80	4	6.70	150	240	13	90	13
95th	26	24	29	37	0.6	102	4.5	7.70	200	340	18	130	21

Fe in %, Au in ppb, other elements in ppm.
** not all 45 000 sample set were analysed for every element listed above.
-- = element not analysed by respective method.

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